FORM PTO-1390 (REV 10-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: P/923-341

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 09/914055

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/KR99/00794	21 December 1999	21 December 1999

TITLE OF INVENTION: PISTON SUPPORTING STRUCTURE FOR LINEAR COMPRESSOR

APPLICANT(S) FOR DO/EO/US: Gye Young SONG

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. [ ] The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information:

Print EFS Form
4 Drawing Sheets (Figs. 1-6)
Intl. Search Report
Inventor Designation Sheet
(Unsigned Declaration)

EXPRESS MAIL CERTIFICATE

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office to Addresses (mail label EL855845471US in an envelope addressed to: Asst. Commissioner for Patents, Washington, D.C. 20231, on August 21, 2001.

Dorothy Jenkins
Name of Person Mailing Correspondence

Dorothy Jenkins
Signature

August 21, 2001
Date of Signature

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/914055	PcT/KR99/00794	P/923-341

	CALCULATIONS PTO USE ONLY	
17. [X] The following fees are submitted:		
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 1,000.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	5 - 20 =	0	X $18.00	$	
Independent claims	1 - 3 =	0	X $80.00	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $270.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 1,000.00	
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$	
SUBTOTAL =				$ 1,000.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ]20 [ ]30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 1,000.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 1,000.00	
				Amount to be refunded:	$
				charged:	$

a. [X] A check in the amount of $ 1,000.00 to cover the above fees is enclosed. Check No. 6107

b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 15-0700. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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REGISTRATION NUMBER

4/pats

PISTON SUPPORTING STRUCTURE FOR LINEAR COMPRESSOR

TECHNICAL FIELD

The present invention relates to a piston supporting structure for a linear compressor, and in particular to a piston supporting structure for a linear compressor in which a spring elastically supporting a piston supports the piston, being only axially contracted and relaxed by the reciprocating movement of the piston in receipt of driving force of a motor, while not being displaced in a radial direction.

BACKGROUND ART

Generally, a compressor constituting a refrigerating cycle apparatus compresses refrigerant introduced from an evaporator and discharges the same to a high temperature and pressure state.

A linear compressor, an example of the above-described compressor, inducts refrigerant gas and compresses the same by driving force of a motor transferred to a piston reciprocating in a cylinder. At this time, the piston is elastically supported by springs at both sides thereof, and the kinetic energy thereof is stored.

As illustrated in Figure 1, the above-described linear compressor includes a closed vessel 1 formed to have a predetermined inner space, an inner case 2 installed at the inner center portion of the closed vessel 1 and formed to have a predetermined inner space, a cover plate 3 for covering and opening one side of the inner case 2, a cylinder 4 connected to the

cover plate 3 so as to be positioned at the inner portion of the inner case 2, an outer lamination 5 connected to the inner side of the inner case 2, an inner lamination 6 connected to the cylinder at a predetermined distance from the outer lamination 5, a magnet 7 inserted between the inner lamination 5 and the outer lamination 6 thereby to construct a motor including them, a piston 8 connected to a cylindrical compression space (P) formed at the inner portion of the cylinder 4 to be reciprocatingly movable, a connecting member 9 formed in a predetermined shape with its one side being connected to the magnet 7 and the other side being connected to one side of the piston 8 for thereby transferring driving force of the motor to the piston 8, a cover 10 for covering and opening the other side of the inner case 2, an inner spring 11 connected between the connecting member 9 and the inner lamination 6, and an outer spring 12 connected between the connecting member 9 and the cover 10.

The inner spring 11 and the outer spring 12 are usually round coil springs.

In addition, a valve assembly 13 for inducting refrigerant gas into the cylinder 4 and discharging compressed refrigerant gas to the outside of the cylinder 4 and a head cover 14 are connected to one side of the cylinder 4.

Unexplained reference numerals 15 and 16 in FIG. 5 each represents a winding coil and an oil feeder.

Hereinafter, the operation of the conventional linear compressor thus constructed will now be described.

When a current is applied to the motor, the magnet 7 linearly reciprocates. The linear reciprocating movement of the magnet 7 is transferred to the piston by the connecting member 9, and thereby the piston 8 reciprocates in the compression space (P) of the cylinder.

In this manner, as the piston 8 reciprocates in the compression space (P) of the cylinder 4, refrigerant gas induced into the closed vessel 1 is inducted into the compression space (P) of the cylinder 4 through a refrigerant inlet passage (F), compressed and discharged to the outside of the cylinder through the valve assembly 13 and the head cover 14 repeatedly.

At this time, the piston 8 is elastically supported by the inner and outer springs 11 and 12 positioned at both sides of the piston 8, while storing and discharging kinetic energy. Hereinafter, the example of the piston supporting structure for the conventional linear compressor of the inner and outer springs 11 and 12 supporting the piston 8 will now be described.

As illustrated in Figure 2, a first supporting plate 17 including a disc unit 17a having a predetermined thickness and a circumferentail unit 17b vertically curved and extended to have an inner diameter corresponding to the outer diamater of the outer spring 12 at the circumferential portion of the disc unit 17a is connected to the inner side of the cover 10.

In addition, a second supporting plate 18 including a disc unit 18a having a predetermined thickness and a circumferentail unit 18 vertically curved and extended to have an inner diameter larger than the outer

diameter of the outer spring 12 at the circumferential portion of the disc unit 18a is connected to the outer side of the connecting member 9 so that it is opposed to the first supporting plate 17.

In addition, a third supporting plate 19 including a disc unit 19a having a predetermined thickness and a circumferential unit 19b vertically curved and extended to have an inner diameter larger than the outer diameter of the inner spring 11 at the circumferential portion of the disc unit 19a is connected to the inner side of the connecting member.

In addition, a fourth supporting plate 20 including a disc unit 20a having a predetermined thickness and a circumferential unit 20b vertically curved and extended to have an inner diameter larger than the outer diameter of the inner spring 11 at the circumferential portion of the disc unit 20a is connected to the outer side of the inner lamination 6 so that it is opposed to the third supporting plate 19.

The outer spring 12 is connected between the first and second supporting plates 17 and 18 thus connected, and the inner spring 11 is connected between the third and fourth supporting plates 19 and 20.

In detail, one end portion of the outer spring 12 is fixedly connected to the first supporting plate 17, and the other end portion is loosely supported by the second supporting plate 18.

In addition, one end portion of the inner spring 11 is loosely supported by the third supporting plate 19, and the other end portion is fixedly connected to the fourth supporting plate 20.

Therefore, when the piston 8 reciprocates by driving force of the

motor transferred to the piston 8 by the connecting member 9, the outer spring 12 and the inner spring 11, as illustrated in Figure 3, are positioned linearly in the axial direction, and then elastically support the movement of the piston 8 while repeatedly being contracted and relaxed and store and discharge kinetic energy into elastic energy at the same time.

Figure 3 and Figure 4 to be explained below illustrate only the operation of the inner spring 11.

However, in the conventional linear motor described above, when the inner and outer springs 11 and 12 for elastically supporting the piston reciprocating in the compression space (P) of the cylinder in receipt of driving force of the motor by the connecting member 9 are contracted and relaxed in the axial direction, the inner and outer springs 11 and 12 each supported by the second supporting plate 18 and the third supporting plate 19 connected to the connecting member 9 connected to the piston 8 are loosely supported. Therefore, as illustrated in Figure 4, when the inner and outer springs 11 and 12 are contracted and relaxed in the axial direction, an eccentricity is generated in a radius direction. Then, as illustrated in Figure 5, an angular moment due to F_a and F_b which are in the reciprocal directions is applied to the piston 8 by the eccentricity of the spring. Subsequently, there arises a problem that an abrasion is generated by the friction between the outer circumferential side of the piston reciprocating in the compression space (P) of the cylinder 4 and the inner circumferential side of the cylinder 4.

TECHNICAL PROBLEMS TO BE OVERCOME IN THE PRESENT INVENTION

Therefore, it is an object of the present invention to provide a piston supporting structure for an linear compressor in which a spring elastically supporting a piston supports the piston, being only axially contracted and relaxed by the reciprocating movement of the piston in receipt of driving force of a motor, while not being displaced in a radial direction, thereby preventing an abrasion of the piston and cylinder and increasing the compressing efficiency of the compressor.

DISCLOSURE OF THE INVENTION

In order to achieve the above-described objects of the present invention, there is provided a piston supporting structure for an linear compressor including: a piston reciprocating in the axial direction in receipt of driving force of a motor; a first spring of which one end portion is fixed to one side of the piston; and a second spring of which one end portion is fixed to the other side of the piston.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagram illustrating an example of a general linear compressor;

Figure 2 is a cross-sectional view illustrating an example of a piston supporting structure of a linear compressor in the conventional art;

Figure 3 is a cross-sectional view illustrating the state of a spring prior

to the operation of a linear compressor in a piston supporting structure for a linear compressor in accordance with the conventional art;

Figure 4 is a cross-sectional view illustrating the state of a spring during the operation of a linear compressor in a piston supporting structure for a linear compressor in accordance with the conventional art;

Figure 5 is a schematic diagram illustrating the state of a moment being applied to a piston by the eccentricity of the spring in a piston supporting structure for a linear compressor in accordance with the conventional art;

Figure 6 is a cross-sectional view illustrating a piston supporting structure for a linear compressor in accordance with the present invention.

MODES FOR CARRYING OUT THE PREFERRED EMBODIMENTS

Hereinafter, the preferred embodiment of the present invention will now be described with reference to the accompanying drawings.

In the drawings, like reference numerals designate like composing elements illustrated in Figures 1 and 2. Thus, the description of such composing elements may be omitted herein.

Firstly, a piston supporting structure for a linear compressor in accordance with the present invention, as illustrated in Figure 6, includes: a piston 8 reciprocating in the axial direction in receipt of driving force of a motor; a first spring 50 of which one end portion is fixed to one side of the piston and of which the other end portion is supported by the inner side of a cover 10; and a second spring 60 of which one end portion is fixed to the

other side of the piston 8 and of which the other end portion is supported by the outer side of an inner lamination 6.

The reciprocating movement of the piston 8 is elastically supported by the contraction and relaxation of the first and second springs 50 and 60 in the axial direction.

The first and second springs 50 and 60 are round coil springs, of which standards are preferably the same.

Hereinafter, the piston supporting structure for the linear compressor in accordance with the present invention will now be described in detail.

Spring fixing supporting members 21 and 21' having a predetermined shape each are fixedly connected to both sides of the piston 8, and one end portions of the first spring 50 and second spring 60 each are fixedly connected to the spring fixing supporting members 21 and 21'.

The spring fixing supporting members 21 and 21' are formed in a hollow disc shape having a certain thickness and a predetermined diameter. The structure of which is characterized in that ring units 21b and 21b' provided with through holes 21a and 21a' having a predetermined diameter are formed at the center, and circumferential units 21c and 21c' vertically curved and extended in order to have a predetermined height thereby to have an outer diameter corresponding to the inner diameter of the first and second springs 50 and 60 are formed at the circumferential portions of the through holes 21a and 21a' of the ring units 21b and 21b'.

Meanwhile, the other end portions of the first spring 50 and second spring 60 each are loosely supported by the spring fixing supporting members

22 and 22' each fixedly connected to the inner side of the cover 10 and the outer side of the inner lamination 6 positioned at a predetermined distance from both sides of the piston 8.

The spring fixing supporting members 22 and 22' are formed in a hollow shape having a certain thickness and a predetermined diameter. The structure of which is characterized in that ring units 22b and 22b' provided with through holes 22a and 22a' having a predetermined diameter are formed at the center, and circumferential units 22c and 22c' vertically curved and extended in order to have a predetermined height thereby to have an outer diameter larger than the inner diameter of the first and second springs 50 and 60 are formed at the circumferential portions of the through holes 22a and 22a' of the ring units.

Therefore, the piston supporting structure for the linear compressor in accordance with the present invention is characterized in detail in that one end portion of the first spring 50 is fixedly inserted into the circumferential portion 21c of the spring fixing supporting member 21 connected to the outer side of the piston 8, and the other end portion is loosely inserted into the circumferential portion 22c of the spring fixing supporting member 22 connected to the cover 10.

Likewise, one end portion of the second spring 60 is fixedly inserted into the circumferential portion 21c' of the spring fixing supporting member 21' connected to the outer side of the piston 8, and the other end portion is loosely inserted into the circumferential portion 22c' of the spring fixing supporting member 22' connected to the inner lamination 6.

Hereinafter, the operation and effects of the piston supporting structure for the linear compressor in accordance with the present invention will be described.

Firstly, when the piston 8 reciprocates by driving force of the motor transferred to the piston 8 by the connecting member 9, the outer spring 12 and the inner spring 11 elastically support the movement of the piston 8 while repeatedly being contracted and relaxed, and store and discharge kinetic energy into elastic energy at the same time.

At this time, one of both end portions of the first and second springs 50 and 60 elastically supporting the piston 8 reciprocating as described above is loosely supported, while one end portion in contact with the piston 8 is contracted and relaxed, being fixed to the piston and reciprocating as a single body mated with the piston 8, and thereby elastically supports the piston. Thus, the first and second springs 50 and 60 are not displaced in a radius direction.

That is, since the first and second springs 50 and 60 are contracted and relaxed in the axial direction without being displaced in a radius direction and thereby elastically support the reciprocating movement of the piston 8, the piston linearly reciprocates only in the axial direction without being displaced in a radius direction when it moves in the compression space (P) of the cylinder 4. Subsequently, the abrasion of the piston 8 and the cylinder 4 is prevented.

INDUSTRIAL AVAILABILITY

In the piston supporting structure for the linear compressor in accordance with the present invention, the first and second springs elastically supporting the piston reciprocating in receipt of driving force of the motor are contracted and relaxed in the axial direction without being displaced in a radius direction, and thereby elastically support the reciprocating movement of the piston, so that the piston can linearly reciprocate in the axial direction in the compression space of the cylinder. Accordingly, a rotation moment is not applied to the piston, thereby preventing the abrasion of the piston and cylinder and the breakage of parts.

In addition, driving force of the motor serves as a suction force and a compression force without a loss due to friction, thereby increasing the compression efficiency of the compressor.

CLAIMS

1. A piston supporting structure for a linear compressor, comprising:

a piston reciprocating in the axial direction in receipt of driving force of a motor;

a first spring of which one end portion is fixed to one side of the piston; and

a second spring of which one end portion is fixed to the other side of the piston.

2. The structure according to claim 1, wherein spring fixing supporting members each are connected to both sides of the piston, and end portions of the first spring and second spring each are fixed to the spring fixing supporting members.

3. The structure according to claim 1, wherein the other end portions of the first spring and second spring are loosely supported by the spring fixing supporting members connected at a predetermined distance from both sides of the piston.

4. The structure according to claim 3, wherein one of the spring fixing supporting members is connected to the inner side of a compressor cover.

5. The structure according to claim 3, wherein one of the spring fixing

supporting members is connected to the outer side of an inner lamination.

FIG. 1

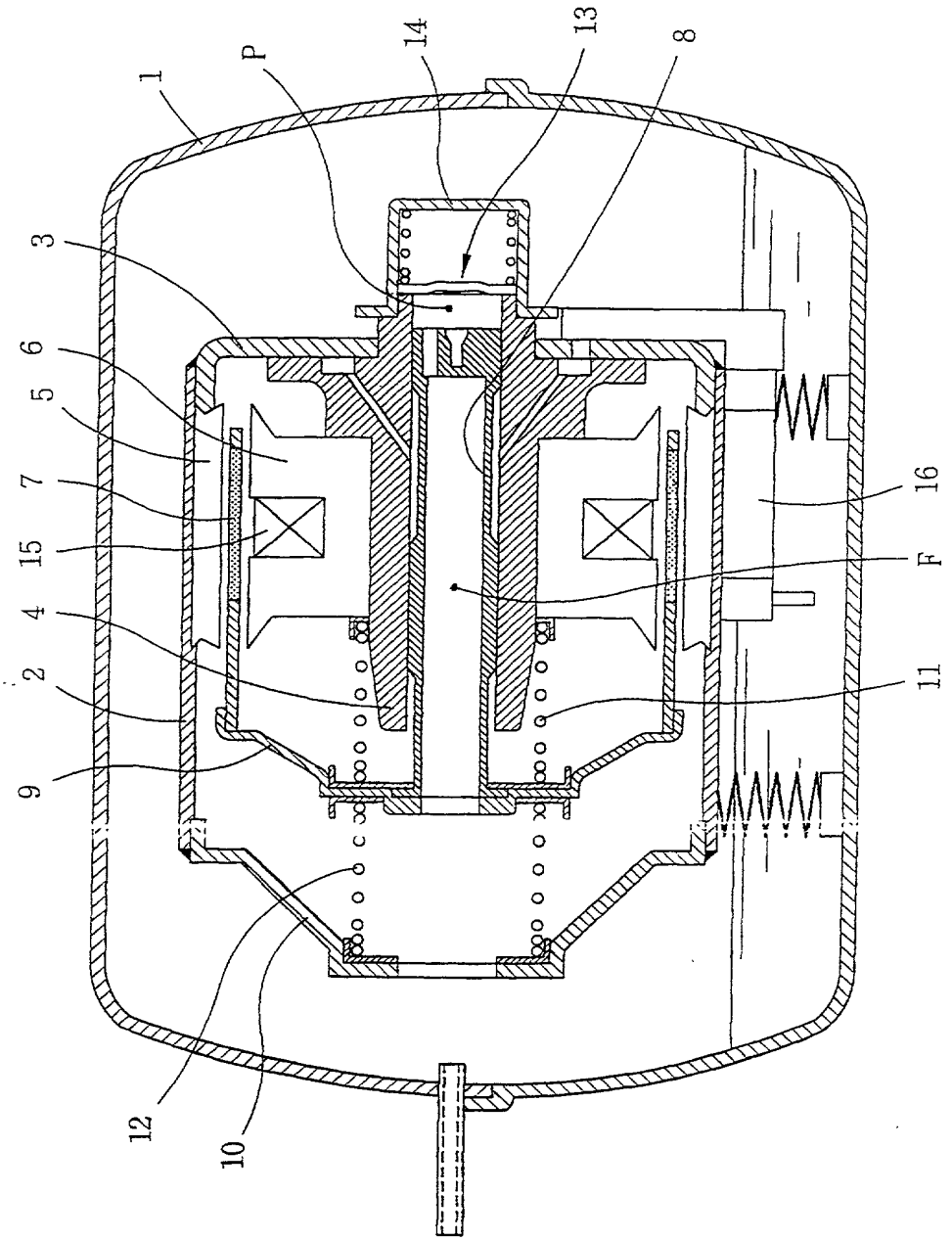


FIG. 2

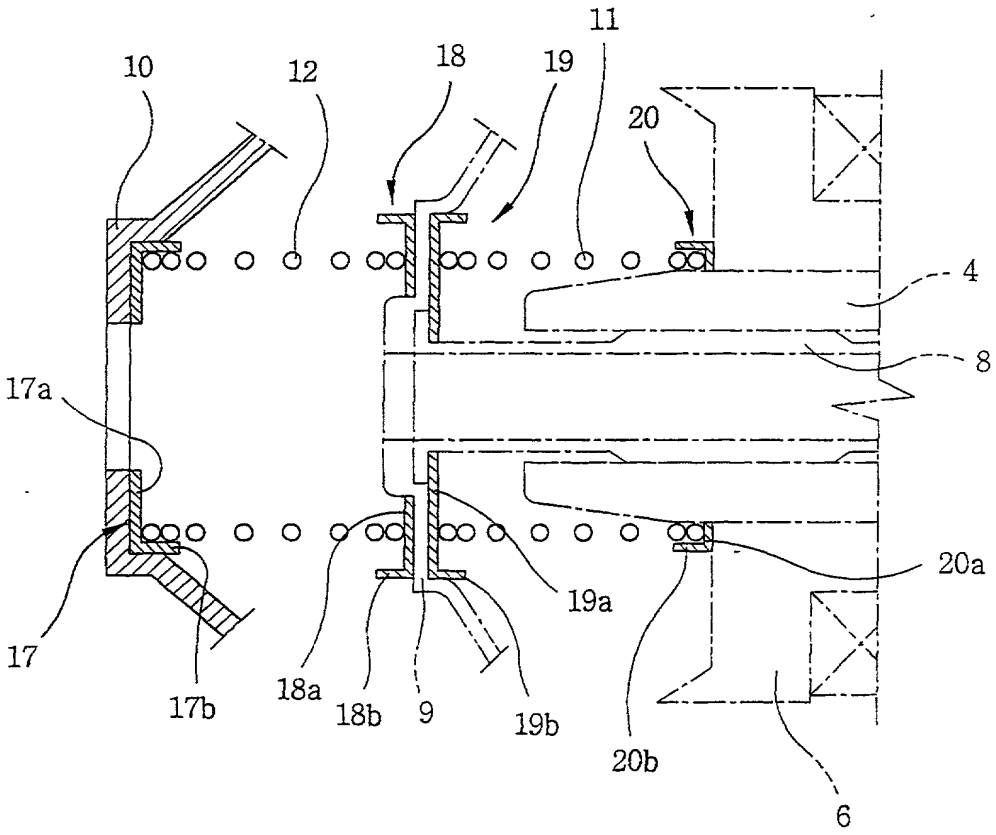


FIG. 3

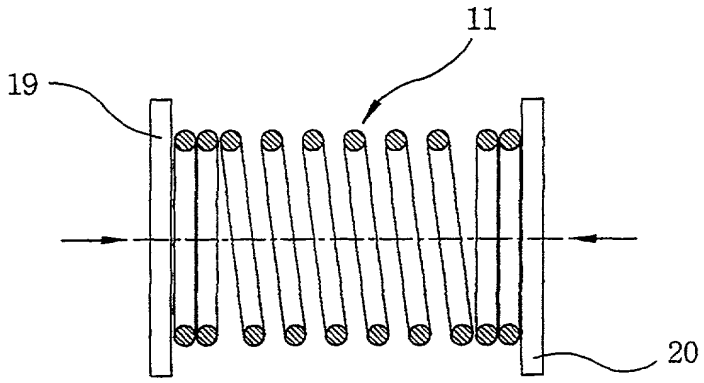


FIG. 4

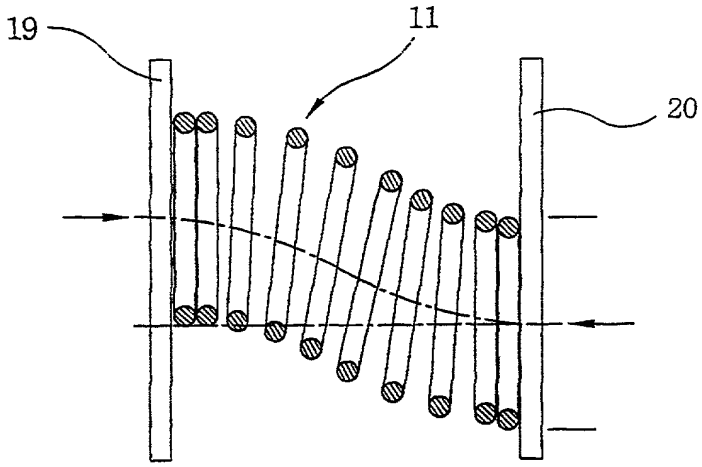


FIG. 5

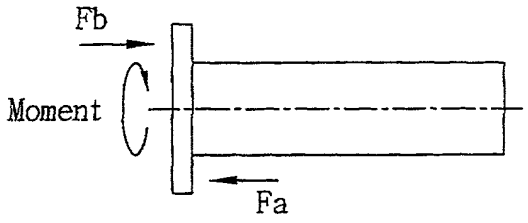
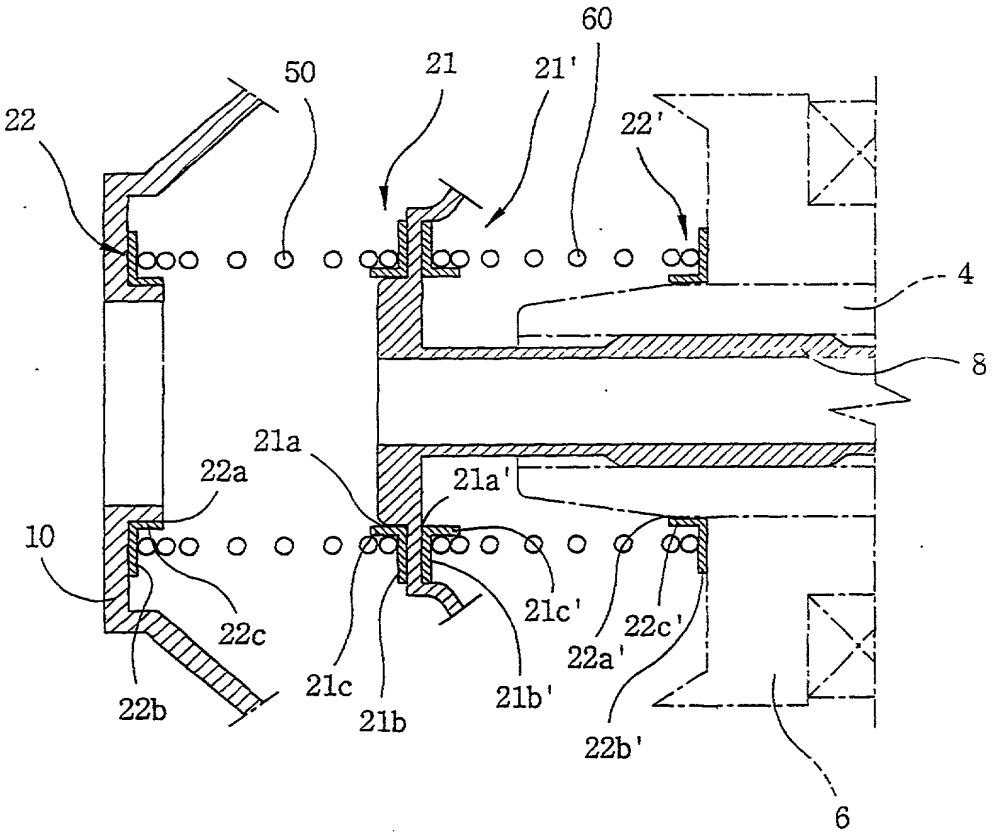


FIG. 6



UNITED STATES OF AMERICA COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION	OFGS FILE NO. P/923-341

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name, that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

PISTON SUPPORTING STRUCTURE FOR LINEAR COMPRESSOR

the specification of which is attached hereto, unless the following box is checked:

☒ was filed on 21 December 1999 as United States patent Application Number or PCT International patent application number PCT/KR99/00794 and was amended on _____ (if any).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate or United States provisional application(s) listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign or Provisional Application(s)

COUNTRY	APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	PRIORITY CLAIMED UNDER 35 U.S.C. 119
			YES ___ NO ___
			YES ___ NO ___
			YES ___ NO ___

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

UNITED STATES APPLICATION NUMBER	DATE OF FILING *(day, month, year)*	STATUS *(patented, pending, abandoned)*

I hereby appoint customer no. 2352 OSTROLENK, FABER, GERB & SOFFEN, LLP, and the members of the firm, Samuel H. Weiner - Reg. No 18,510; Jerome M. Berliner - Reg. No. 18,653; Robert C. Faber - Reg. No. 24,322; Edward A. Meilman - Reg. No. 24,735; Steven I. Weisburd - Reg. No. 27,409; Max Moskowitz - Reg. No. 30,576; Stephen A. Soffen - Reg. No. 31,063; James A. Finder - Reg. No. 30,173; William O. Gray, III - Reg. No. 30,944; Louis C. Dujmich - Reg. No. 30,625, Douglas A. Miro - Reg. No. 31,643, and Michael J. Scheer - Reg. No. 34,425, as attorneys with full power of substitution and revocation to prosecute this application, to transact all business in the Patent & Trademark Office connected therewith and to receive all correspondence.

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FULL NAME OF SECOND JOINT INVENTOR (IF ANY)	INVENTOR'S SIGNATURE	DATE
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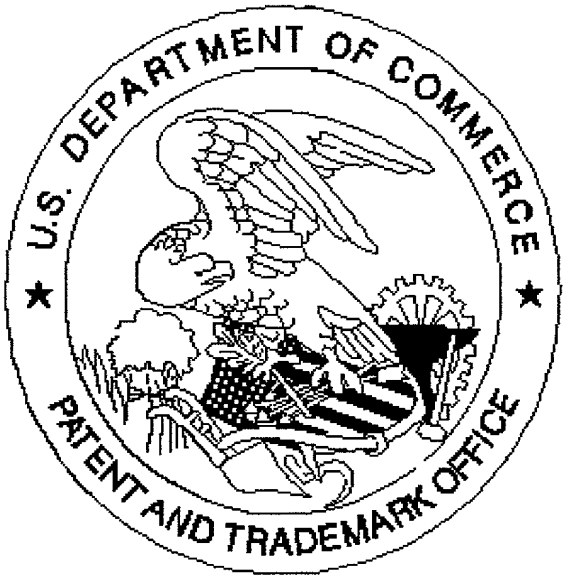

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